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Agricultural Experiment Station

University of Kentucky

THOMAS P. COOPER, Director

ACIDOSIS OF PREGNANT EWES: SO-CALLED PREGNANCY DISEASE OF SHEEP

CIRCULAR NO. 39.

Lexington, Ky.

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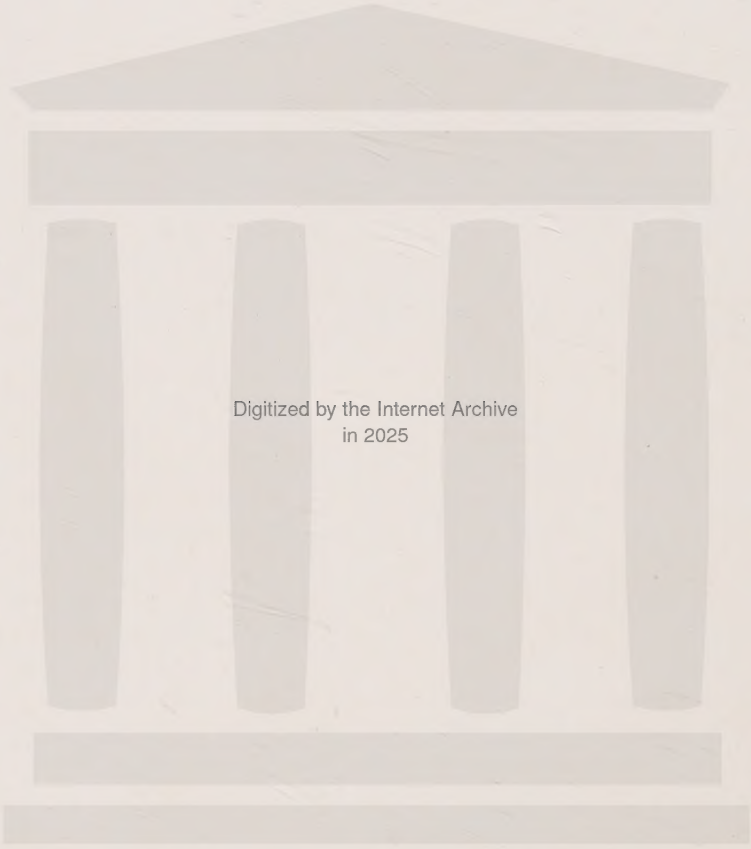

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CIRCULAR NO. 39.

Acidosis of Pregnant Ewes: So-Called Pregnancy Disease of Sheep

By W. W. DIMOCK, DANIEL J. HEALY and F. E. HULL

Acidosis of pregnant ewes, the so-called pregnancy disease of sheep, occurs during the months of January and February, a few days before or within several weeks of lambing. The loss observed in certain flocks is from five to twenty per cent of ewes.

The disease has been observed in different parts of the United States and in various European countries. It has been mistaken for hemorrhagic septicemia, grub in the head, nodular disease, botulism and for poisoning. Dr. James Law, in Veterinary Medicine, Vol. 3, 3rd edition, describes a similar condition under the title of "Neurasthenia in Pregnant Ewes." In Europe the disease is spoken of as "an acute liver trouble." Prior to 1919 Dimock observed this disease in the central west and determined that cases presented for examination were apparently non-infectious as all attempts to demonstrate the presence of an infective agent by bacteriological methods and animal inoculations failed.

The quality of feed and the method of feeding are important factors in causing the disease, as the greatest losses from acidosis of pregnant ewes have occurred in flocks on roughage and insufficient pasture or in flocks fed considerable corn but no alfalfa or clover. Many farmers report that the disease appears a day or two after salting. It has been observed, also, that ewes frequently go down with the disease directly following a sudden change in the weather, such as a cold wave or snow storm.

The disease is apparently non-infectious and non-contagious as repeated attempts made at this Station failed to transmit the disease, or to isolate a causative microbe. The non-infectious

nature of the disease, together with observations made in the field, led to the conclusion that acidosis or pregnancy disease is primarily a nutritional problem. Clinically the animal presents symptoms suggestive of toxemia.

It was determined (Healy) that the urine of affected ewes showed evidence of kidney trouble, as chemical tests revealed the presence of albumen, acetone and increased ammonia. Following the study of the urine careful chemical examinations of the blood were made with very significant results. The ewes with typical symptoms of acidosis or pregnancy disease showed a low calcium content of the blood serum as compared with normal pregnant and normal non-pregnant ewes examined. A study was made of the calcium, potassium and phosphorus content of the blood serum from non-pregnant ewes, normal pregnant ewes at term and pregnant ewes with acidosis. The following tables show the findings as to calcium and potassium. Differences in phosphorus content were not so striking.

TABLE 1. Calcium Content of the Blood Serum of Ewes. Milligrams of Ca in 100 Cubic Centimeters.

Pregnant		Not Pregnant Normal
With Acidosis	Normal At Term	
8.6	10.4	10.7
8.0	9.3	10.4
7.6	9.2	10.2
7.5	9.1	9.9
7.2	8.8	9.7
7.2	8.5	9.6
6.6	8.2	9.5
6.6	.....	9.4
6.6	.....	9.1
6.2	.....	8.5
5.0	.....	.....
4.7	.....	.....
4.2		
Average 13 Ewes 6.6	Average 7 Ewes 9.1	Average 10 Ewes 9.7

TABLE 2. Potassium Content of the Blood Serum of Ewes. Milligrams of K in 100 Cubic Centimeters.

Pregnant		Not Pregnant Normal
With Acidosis	Normal At Term	
82.9	27.9	33.9
58.7	27.7	32.8
52.5	21.1	32.8
47.6	20.6	30.9
40.5	20.3	28.8
38.7	20.1	26.7
34.5	19.6	26.1
26.3	.....	21.7
15.2	.....	20.6
.....	.....	19.6
Average 9 Ewes 44.1	Average 7 Ewes 22.5	Average 10 Ewes 30.9

Tables 1 and 2 indicate that, in these cases of acidosis of pregnant ewes, the blood calcium content is distinctly diminished and the potassium content greatly increased. At present it is not known that this increase of potassium would be injurious to the ewe. The deficiency in calcium content, however, indicates that the pregnant ewes coming down with this disease were not properly nourished in regard to calcium.

The calcium content of most feeds is known, and it was observed that the feed of flocks in which cases of acidosis or pregnancy disease developed was low in calcium as compared with the feed of other flocks in which acidosis or pregnancy disease did not develop. The Experiment Station flock has been under observation for eleven years. During this time but one case of acidosis or pregnancy disease has occurred in this flock. Other small flocks under observation, that were fed clover or alfalfa hay and the proper grain ration, developed no cases. On the other hand, in those flocks in which acidosis or pregnancy disease developed, it was found that the ewes were on winter pasture, possibly being fed a little corn stover or a small amount of corn.

In a few instances the ewes received corn and oats. In very few flocks where the disease developed the ewes received what was apparently a properly balanced diet.

SYMPTOMS

The symptoms of acidosis or pregnancy disease are lagging behind, standing alone, loss of appetite, nervousness, irritability, grinding the teeth, walking in circles, standing with head pressed against a hard object and partial or complete blindness. Later the animal is unable to stand, has partial or complete coma with convulsions or spasms when disturbed.

PREVENTIVE MEASURES

After the ewe has sickened with the disease there is almost no chance of saving her. We have tried many different things without beneficial results and have finally concluded that prevention is the only certain method of dealing with this condition. Sufficient quantities of proper food are necessary in preventing acidosis of pregnant ewes. Feeding, as used in this publication, refers to the quantity and quality of feeds necessary to maintain the normal calcium content of the blood of the pregnant ewe.

Since it is recommended by authorities on the management and care of sheep that the ewes should be "flushed" during the mating season so that they will gain from 5 to 7 pounds,[1] it is imperative after they become pregnant that they retain this weight and at the same time maintain the proper calcium balance. To do this it is necessary that the ewes, from the beginning of pregnancy, receive succulent pasture, preferably leguminous, or roughage rich in calcium. It seems to the authors of this circular that our investigations indicate that certain roughages of a leguminous nature, if fed, will, because of their high calcium content, prevent the pregnancy disease. In order that we may get results on many farms we hope that a number of our sheep breeders will feed their flocks according to the following suggestions and will let us know what the result of this feeding is upon their flocks; if succulent pasture is not available,

[1] Marshal, F. R. and C. G. Potts, Bull. 996, U. S. D. Agric., Oct., 1921.

a part of the roughage should consist of a legume hay, as alfalfa, red clover, soybean, cowpea or clover mixed with timothy. Ewes may receive as much as two pounds of hay a day. Grain mixtures fed to maintain weight should contain a considerable amount of linseed oil meal as, for example, in the following mixtures, a half pound of which may be fed to each ewe per day or as needed during the period of pregnancy:

Mixture 1. (Experiment Station Farm)
- Oats ..... 310 lbs.
- Wheat Bran ..... 100 lbs.
- Linseed oil meal ..... 50 lbs.
- Gradually increase oil meal to 100 lbs.

Mixture 2.
- Corn ..... 200 lbs.
- Oats ..... 200 lbs.
- Wheat bran ..... 100 lbs.
- Linseed Oil Meal ..... 50 lbs.

Mixture 3.
- Corn ..... 300 lbs.
- Wheat Bran ..... 150 lbs.
- Linseed oil meal ..... 50 lbs.

Table 3, adapted from Henry and Morrison's "Feeds and Feeding," 19th edition, shows the percentage of calcium in various hays and in corn stover. The important fact shown by these figures is that the legumes contain a much larger proportion of calcium than the grasses, and the grains, especially corn, contain very little. Corn stover and linseed oil meal, however, contain a fair proportion.

TABLE 3. The Calcium Content of Various Hays, Grains, and Linseed Oil Meal.

	Per Cent Calcium
Bluegrass hay	0.31
Timothy hay	0.18
Corn stover	0.47
Alfalfa hay	1.39
Red Clover hay	1.14
Soybean hay	1.23
Cowpea hay	1.81
Equal parts of clover and timothy	0.66
Corn	0.01
Wheat Bran	0.06
Oats	0.10
Linseed oil meal	0.36

Analyses of two samples of lespedeza (Japan clover) from experimental plots on the Station farm gave 0.93 and 1.13 per cent of calcium in the air-dried material.

While feeding, as above indicated, is the most natural and satisfactory method of maintaining the proper calcium balance in pregnant ewes, it seems reasonable to suppose that feeding the ewes a suitable calcium compounded in addition might aid in producing the same result. A mixture of one part of fine-ground limestone, one of steamed bone meal and three of salt would be suitable, to be used instead of salt alone.

SUMMARY

Acidosis of pregnant ewes is, according to the result of our investigations, a nutritional disease.

In ewes showing typical symptoms of acidosis of pregnancy, the calcium content of the blood serum is low.

The urine contains albumen, acetone, and increased amount of ammonia.

The mortality from this disease varies from five to twenty per cent in affected flocks.

Following the development of symptoms treatment has proved of no value.

Prevention depends upon maintaining the proper supply of calcium, preferably by the use of feeds relatively high in this element.

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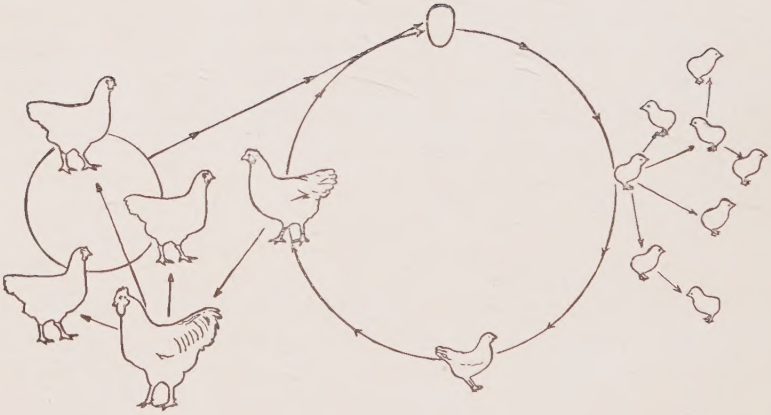
BACILLARY WHITE DIARRHEA

CIRCULAR NO. 40.

Lexington, Ky.
November, 1928



THE CYCLE OF INFECTION IN BACILLARY WHITE DIARRHEA.

The egg containing **Salmonella pullora** produces a chick which is infected with bacillary white diarrhea. The disease is spread from chick to chick thru the body discharges. Pullets surviving the acute form of the disease become carriers, having the infection localized in the ovary. These hens, in turn, lay infected eggs, thus producing diseased chicks. The infection is probably spread thru the breeding flock by the male bird, which acts as a passive carrier of the disease.

CIRCULAR NO. 40.

Bacillary White Diarrhea

By P. R. EDWARDS and F. E. HULL

Bacillary white diarrhea is a specific infectious disease of chickens. In very young chicks it assumes an acute, highly fatal form. In older birds it is usually a chronic disease having no apparent effect upon the fowls carrying the infection. At times, however, the infection becomes active, producing an acute form of the disease usually terminating in death.

The term "white diarrhea" has been applied by poultrymen to a variety of conditions, particularly intestinal disorders in which diarrhea is manifest. These conditions may be induced by chilling or overheating the chicks or by improper feeding. Such occurrences are relatively rare however. Our tests show that the great majority of chicks dying at less than two weeks of age are affected with bacillary white diarrhea. This disease is not caused by overheating or chilling, but is due to a microscopic organism, a bacterium, which is called *Salmonella pullora.*

Bacillary white diarrhea probably exists wherever chickens are found. At least we know it is one of the most widely distributed diseases infecting domesticated fowls. It has been reported from the United States, Canada, Europe and Japan. This disease is probably the most destructive with which the poultrymen must cope. Not only does the disease cause the death of millions of chicks annually, but its effects are evident in other forms. This infection is responsible for lowered egg production, a marked reduction in fertility of eggs, lowered hatchability of eggs due to death of the embryo, stunting of chicks that survive the acute form, and death of adult hens.

SYMPTOMS.

Chicks are most susceptible to the disease in the first few days of life but symptoms may not be observed until the birds

are more than a week old. The disease usually first shows itself in a loss of appetite and sluggishness. The chicks do not move about actively but stand in one place and chirp continually. The feathers become ruffled and the wings tend to droop. Usually the infected chicks will remain very near the hover. As the disease progresses a diarrhea becomes evident and the excreta are usually white or light gray in color. The white discharge may adhere to the fluff in sufficient amount to seal the vent, thus bringing about the condition known to poultrymen as "pasting up behind." Finally the chick becomes so weak that it is unable to stand and lies on its side gasping for breath. Death soon follows.

At times the course of the disease is so rapid that chicks may die during the night without previously having shown any signs of illness. The typical diarrhea is not always observed. In cases where the disease runs a rapid course this symptom may not appear and its absence is not indicative that the chicks are not suffering from this infection.

There are no definite symptoms of the chronic form of the disease in adult fowls. Very often infected individuals may show unthriftiness and lameness and a tendency to develop unusually large abdomens or, as the poultrymen designate them, "water butts." These symptoms may be produced by a variety of other causes and it is impossible to diagnose white diarrhea infection in adult birds by a physical examination. The acute form of the disease in adult fowls first causes a paleness of the comb and visible mucous membranes, the comb appearing shrunken, scaly and gray in color. The fowls appear listless and as the disease progresses depression becomes marked, with the head down and the wings sagging. The appetite is lessened and diarrhea is usually present, the tail feathers being soiled with yellowish white feces. These symptoms are very similar to those observed in hens suffering with fowl typhoid infection.

MORTALITY.

The mortality of the disease varies widely. In some cases no more than 5 per cent of the chicks will die, while in other cases

the entire lot of chicks may be lost. In the majority of cases the loss of chicks will be from 25 to 75 per cent. The number of chicks surviving the disease greatly depends upon the number originally infected and the care which they receive. If a large number of the chicks are infected at the outbreak of the disease the loss will usually be high while if only a small number are originally infected the death rate will be considerably lower. If a group of chicks which are suffering with bacillary white diarrhea are exposed to overheating or chilling the mortality will be exceedingly high. Infected chicks are much more susceptible to unfavorable environments than are healthy chicks. Consequently any deviation from the most favorable conditions will greatly increase the deaths due to bacillary white diarrhea.

In older hens deaths due to the disease usually occur as individual cases. Deaths of this kind are caused by a chronic localized infection suddenly becoming acute and systemic. The causes of such changes are not well understood. It is difficult to estimate the mortality in adult birds due to bacillary white diarrhea. In one case under our observation a group of hens, all of which were known to be infected, were kept under ordinary farm conditions for one year. During the year 40 per cent of these hens died. In a second group of infected hens 15 per cent of the flock died during five months in which they were under observation. Computed on the basis of one year this would be 36 per cent mortality. Possibly these are extreme cases and the mortality among infected hens in general is not so high. However, the fact remains that a large number of hens affected with the chronic form of the disease die, and this constitutes a serious loss to the poultryman whose flock harbors a large number of such birds.

There is still another source of loss in adult hens due to this infection. This is the feeding of eggs or other material containing the bacterium which causes bacillary white diarrhea. Some poultrymen feed raw infertile eggs from their incubators to their flocks. Others may feed the egg shells from the incubators. Such material often contains large numbers of *Salmonella pullora,* the bacterium causing white diarrhea. Such a procedure

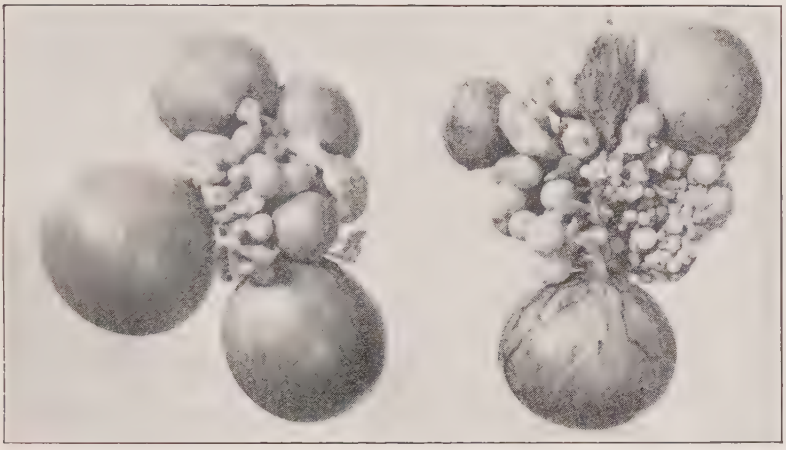
may cause the appearance of an acute form of the disease in the birds. Cases have been recorded in which one-third to one-half of the entire flock was lost, due to feeding infected eggs.

ANATOMICAL CHANGES.

The post-morten appearance of chicks dying of the disease is not always typical. However, some rather characteristic changes have been noted.

The chicks may be emaciated, the crop is usually empty, the intestines pale and almost empty, sometimes distended with gas. The liver is often pale, with dark red streaks or blotches. At times the liver is quite yellowish. In chicks which attain considerable age before death small, white necrotic areas may appear on the liver. The lungs are usually pink or red. In a large number of infected chicks soft, white, cheesy spots may be found in the lungs. The yolk in chicks suffering with bacillary white diarrhea seems to be absorbed very slowly. The unabsorbed yolk is considered by some investigators as characteristic of the disease. The yolk may vary from the size of a chestnut down to the size of a small pea. In chicks dying during the first few days of life the yolk is large and watery. In slightly older chicks the unabsorbed yolk is smaller and the contents gelatinous. In cases of long standing the yolk is small and dense. It cuts with difficulty and the contents are cheesy. The ceca are often filled with a cheesy material and in older chicks abscesses of the ceca are occasionally found.

The post-mortem appearances in acute cases in adults are quite similar to those found in fowl typhoid. The heart is usually enlarged and congested, with small, white necrotic areas in the heart muscle. The pericardial sac may be enlarged, containing whitish, purulent exudate. The liver is enlarged and softened and the surface is sprinkled with small, grayish-white areas of necrosis. There is usually organized exudate covering the liver which has the appearance of a grayish-white film. The spleen is enlarged and contains white areas of necrosis. The ovary is often intensely congested and usually several dark, discolored, misshapen ova will be found.



Ovaries from two hens in laying condition. These hens were carriers of bacillary white diarrhea infection. Some of the smaller ova are misshapen and angular. **Salmonella pullora** was isolated from each of these ovaries.

Ovaries from two hens which were carriers of bacillary white diarrhea infection. Practically all the ova are abnormal. **Salmonella pullora** was isolated from each of these ovaries.

DIAGNOSIS.

While the symptoms and post-mortem appearances found in chicks are rather characteristic it is impossible to definitely diagnose the disease except by laboratory examination. In the laboratory the diagnosis is made by the cultivation and identification of the bacterium causing the disease.

In the adult fowl the disease may sometimes be diagnosed at post-mortem by the changes found, especially the appearance of the ovary. Here again, however, absolute certainty in the diagnosis can be obtained only by the cultivation and identification of the infecting bacterium. In the living, adult fowl the infection may be diagnosed by means of the agglutination test or blood test. This method will be described later.

TREATMENT.

Several methods of treatment of chicks for bacillary white diarrhea have been recommended. The treatment which seems to have given the most satisfactory results in the feeding of sour skim-milk. The milk is used to replace the drinking water. Another method of treatment is the addition of antiseptics such as bichloride of mercury, sulphocarbolates, creosote, potassium permanganate, hypochlorites, etc., to the drinking water. However, none of these treatments has been satisfactory and it is the opinion of most investigators that treatment should not be resorted to. It is better that the infected chicks be destroyed to prevent the spread of infection. The diseased chicks discharge large numbers of the bacterium causing infection in their droppings and their presence in the flock is a menace to the health of the other chicks.

Medication of the drinking water, while it will not cure infected individuals, may reduce the spread of the infection thru this medium. In treating the drinking water 7½ grains of bichloride of mercury should be added to one gallon of water. Instead of bichloride, hypochlorite solutions may be used to treat the drinking water. If this type of antiseptic is used one ounce of the commercial hpochlorite solution, such as zonite or B-K, should be added to one gallon of water. Earthenware or wooden

receptacles should be used, since the antiseptics tend to corrode metal.

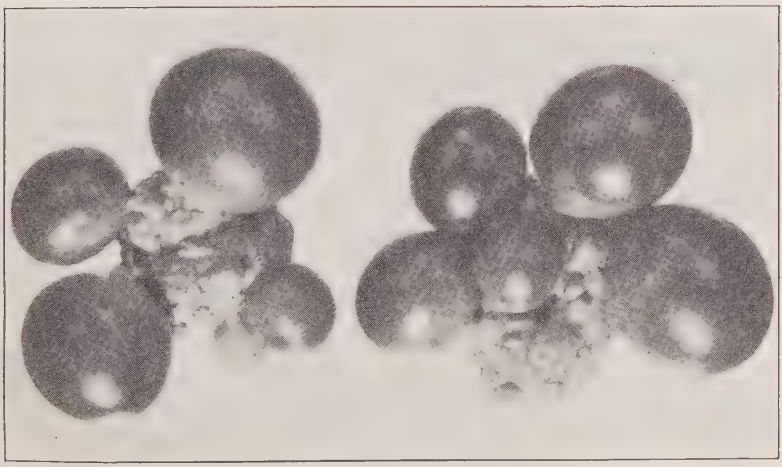
Of greater importance than treating the drinking water is the proper construction of the fountains and feed hoppers. These should be so arranged that the chicks cannot walk in them or otherwise contaminate them. The contamination of the feed and water with the excreta of diseased birds often leads to increased losses.

The brooder should be thoroly cleaned as often as possible and the disinfection of the house with a 5 per cent solution of cresol may be beneficial.

It should be remembered that any measures taken in the treatment of the disease are likely to be of very little benefit and that the solution of the problem lies in prevention of the infection and not in treatment.

NATURAL INFECTION AND TRANSMISSION.

In order to successfully control any disease it is necessary that the methods of transmission be known. Due to the work of a number of investigators we now have a rather thoro understanding of the ways by which bacillary white diarrhea is trans-



Ovaries from two normal hens in laying condition. Note the round, regular shape of the ova.

mitted. It has been found that certain chicks are diseased when hatched. This is because the hen which has the chronic form of the disease carries the infection in the ovary. Some of the eggs laid by such a hen contain the bacterium responsible for the disease. It has been shown that 5 to 25 per cent of the eggs laid by an infected hen contain *Salmonella pullora.* These infected eggs are hatched and produce diseased chicks. These infected chicks throw off large numbers of the bacterium and transmit the disease to the chicks with which they are associated. In this way a high percentage of the chicks may contract the infection. The majority of these affected chicks die but some survive, and many of these become chronic carriers of the infection. Such hens will, in turn, lay infected eggs and produce diseased chicks. Thus the disease is perpetuated. It has been observed that most diseased chicks which survive the infection are stunted and unthrifty and become likely subjects for roup and many other diseases.

There are other methods of transmission of the disease in baby chicks than passage of the infection thru the egg. As has been mentioned before, the disease is transmitted from chick to chick in the brooder thru the contamination of feed and water. Incubators are also a source of spread of the disease. This is more noticeable in the forced draft type of machine. Not only is the disease spread in the incubators by the droppings of the chicks but the down which circulates in the machine constitutes a serious danger. The down from chicks which are hatched with the disease may be loaded with *Salmonella pullora.* This down circulates with the air currents and spreads the infection from tray to tray. Thus chicks which are free from the disease may contract it in the incubator.

Another source of infection in baby chicks is infected quarters. Very often a brooder is used to raise a group of infected chicks and later another lot of day old chicks will be placed in the brooder before it has been thoroly cleaned and disinfected. The second lot of chicks may then contract the disease and serious loss result.

The spread of the infection among adult birds is not so rapid as the spread among chicks. It is well known that feed-

ing infected material to adult birds results in both acute and chronic infection. The transmission of the disease from hen to hen thru infected litter and ordinary contact and association is not rapid. However, when infected and noninfected hens are in the same flock the infection may spread by the eating of infected eggs.

A more serious spread of the disease from hen to hen may be caused by the male birds. Adult hens which are infected are thought to discharge *Salmonella pullora* from the oviduct. The male bird may thus act as a passive carrier of infection since hens readily become infected when the organism causing the disease is placed in the cloaca or lower portion of the oviduct. The possibility of an infected male transmitting the disease directly to noninfected hens is thought to be slight. However, an infected male bird should not be used for breeding.

PREVENTION.

The prevention of bacillary white diarrhea is dependent upon two factors:

(1) The removal of all infected adults from the breeding flocks.

(2) The prevention of infection in the chicks after they are hatched.

The removal of infected birds from the breeding flock is dependent upon the agglutination test or blood test. This test is conducted in a similar manner to the test for contagious abortion in cattle and typhoid fever in the human. The agglutination test for bacillary white diarrhea is a very accurate method of diagnosis and when properly carried out by an experienced person gives exceedingly good results. If it is not properly conducted, however, the results of the test will not be satisfactory. Certain agencies have published literature tending to show that the agglutination test is inaccurate. Most of these criticisms have originated from persons who are seemingly interested in discrediting the test. However, this test when properly carried out and intelligently applied has proved itself one of the most valuable of diagnostic methods.

If hens one year old or more are to be used as breeders they are usually tested in the fall or early winter, after the flock has been culled. This will eliminate the unnecessary testing of birds which are to be removed from the flock because of disqualifications or low production. If the eggs from pullets are to be used for hatching, the testing should be delayed as long as possible and yet have the test completed before the start of the hatching season. In order to obtain the most satisfactory results pullets should not be tested before January or February. This will permit the eggs being used for hatching and most pullets will be fully developed and well into production at this time. This is very important because experience has shown that some of the pullets which, tested in the early fall, give a negative reaction will, if tested later, give a positive reaction. Such birds, if tested early in the fall, would be left in the breeding flock and later produce infected chicks.

When it is possible to use only mature birds as breeders, this should be done. Not only is it more difficult to detect bacillary white diarrhea infection in the pullet than in the older hen, but the eggs of the pullet are frequently lower in hatchability and usually produce chicks of less vigor than do the eggs of mature birds.

In order to blood test chickens it is necessary that a sample of blood be obtained from each bird in the flock. The fowls are first leg banded. A small, sharp knife is used to cut the wing vein just above the second joint. As the blood flows from the vein it is collected in a small vial until 2 or 3 cubic centimeters are obtained. The tube is then stoppered and labelled with the number on the birds leg band. The tube is placed in a slanting position until the blood has completely clotted. The samples are then placed in the refrigerator until thoroly chilled and as soon as possible they are sent to the laboratory where the test is to be conducted.

When the blood reaches the laboratory the serum, or the clear, fluid portion of the blood, is removed from the bleeding vials and placed in a suspension of *Salmonella pullora*. This test fluid is composed of a suspension of the bacteria in distilled water to which has been added .85 per cent of common salt and

.5 per cent of carbolic acid. Just enough bacteria are present in this suspension to give a slight turbidity which is made to correspond to the cloudiness exhibited by a permanent standard. The serum is added in definite amount to a known volume of the test fluid so that the dilution of serum is the same in every case.

After the samples of serum have been added to the test fluid and thoroly mixed, they are placed in an incubator and left for 48 hours. They are then removed and the readings are made. Serum from an infected bird causes the bacteria to become clumped and fall to the bottom of the tube. Serum from non-infected birds is without effect upon the test fluid and the bacteria remain evenly suspended thruout the medium. Thus it is possible to determine what fowls are carriers of bacillary white diarrhea infection.

Other tests have been described by which bacillary white diarrhea can be detected. One of these is the "pullorin" test or wattle test. This test has not been found to give satisfactory results. A modification of the agglutination test called the "rapid test" or slide method has also been described. When this method is used by a competent person it gives fairly good results but it is fully as difficult to interpret and must be performed with quite as much care and skill as the slow method if accurate results are to be obtained.

When the results of the test are received from the laboratory the birds which are designated as positive reactors should be immediately removed from the breeding flock. Certain birds may be designated as doubtful or suspicious reactors. This means that the serum of the infected bird did not give a complete, clear cut reaction when placed in the test fluid but that some change was apparent in the test. These birds should also be removed from the breeding flock since the majority of them can be demonstrated to be carriers of the infection if post-mortem examinations are made.

The hens which give a positive reaction will usually be found to be unthrifty birds and low producers. In most instances they are birds which will not lay sufficient eggs to make them profitable.

In one instance under our observation a flock of 200 birds was tested and 50 per cent of the flock reacted to the test. These hens were divided into two pens, the reacting birds in one pen, the non-reacting birds in the other. The non-reactors laid approximately twice as many eggs as the reactors. Furthermore, chicks were hatched from these two flocks. The hatchability of the eggs from the non-reactors was much higher than the hatchability of the eggs from the reactors. A very high percentage of the chicks from the non-reactors survived while nearly all the chicks hatched from the eggs of the reactors died of bacillary white diarrhea.

After the reacting birds have been removed from the flock the house and premises should be thoroly cleaned and the house should be disinfected with 5 per cent cresol.

After infection has been eliminated from the breeding stock there still remains the necessity of preventing the chicks becoming infected after they are hatched. This is purely a matter of sanitation. If it is possible to hatch the eggs at home this is highly desirable. Before the eggs are placed in the incubator the trays and machine should be thoroly cleaned with soap and hot water and disinfected with 5 per cent cresol solution.

Very often it is impossible to hatch the eggs at home. If this is the case the eggs should be taken to a hatchery which is hatching only eggs from blood tested stock and where strict sanitation is adhered to. Very often hatcheries run a special incubator for eggs from blood tested hens. This may be used. However, we wish to emphasize the desirability of hatching eggs at home where this can possibly be done. At any hatchery chicks from many flocks come in direct or indirect contact. The newly hatched chicks are extremely susceptible to infection and the dangers of disease are multiplied.

Before the young chicks are placed in the brooder it should be thoroly cleaned, washed with hot lye water and disinfected with cresol solution. For each succeeding group of chicks the brooder should be cleaned and disinfected in the same manner.

The containers for feed and water should be kept as clean as possible and should be so constructed that the chicks cannot contaminate them with their droppings. Furthermore it is very

important that the chicks be given no infected feed. Raw, infertile eggs are sometimes fed to young chicks as a source of vitamin D. These eggs may contain *Salmonella pullora* and it is not advisable to feed them to the chicks. Cod liver oil added to the mash will furnish vitamin D.

If the foregoing plan be strictly adhered to the loss of chicks from bacillary white diarrhea should be slight. It must be remembered, however, that it is necessary to test the breeding flock each year until no more reacting birds are found. Only by the strictest attention to details is it possible to eliminate this disease.

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